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Effects of shortening the dry period of dairy cows on milk production, energy balance, health, and fertility: A systematic review

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ABSTRACT

A dry period of 6–8 weeks for dairy cows is generally thought to maximise milk production in the next lactation. However, the value of such a long dry period is increasingly questioned. In particular, shortening the dry period shifts milk production from the critical period after calving to the weeks before calving. This shift in milk production could improve the energy balance (EB), health and fertility of dairy cows. The objective of this study was to systematically review the current knowledge on dry period length in relation to milk production, EB, fertility, and health of cows and calves.

A meta-analysis was performed for variables where at least five studies were available. Overall, both shortening and omitting the dry period reduces milk production, increases milk protein percentage and tends to reduce the risk of ketosis in the next lactation. Individual studies reported an improvement of EB after a short or no dry period, compared with a conventional dry period. Shortening or omitting the dry period did not affect milk fat percentage and shortening the dry period did not alter the odds ratio for mastitis, metritis, or fertility measures in the next lactation. So, current evidence for an improvement of health and fertility of dairy cows is marginal and may be partly explained by the limited number of studies which have evaluated health and fertility in relation to dry period length, the limited number of animals in those studies and the variable responses reported.

Introduction

The practice of drying off dairy cows at 6–8 weeks before calving dates back to the early 1900s and has since been widely applied on dairy farms (Dix Arnold and Becker, 1936). Originally, this practice was based on the experience of farmers and dairymen and lacked scientific evidence. Smith (1959) noted that the role of the dry period was to restore body condition after lactation and to repair and regenerate the alveolar system in the mammary gland. At present, the main aims of the dry period are to treat cows with subclinical mastitis with antibiotics (Neave et al., 1966; Bradley et al., 2011) and to maximise milk production in the next lactation (Kuhn et al., 2005). Mammary cell renewal has been shown to be greater during a dry period of 8 weeks than when cows are milked up to calving (Capuco et al., 1997), supporting the importance of the dry period in allowing senescent mammary epithelial cells to be replaced before parturition. Large numbers of renewed secretory cells in the mammary gland are considered to be responsible for peak milk production during early lactation (Capuco et al., 2001).

There has been much recent discussion about whether the traditional dry period of 6–8 weeks is optimal (Collier et al., 2004; Grummer and Rastani, 2004), with studies showing that continuously milked cows ('no dry period') had better energy balance (EB), health, and fertility in the next lactation (Andersen et al., 2005; Rastani et al., 2005). Nevertheless, the original advice to dry off cows 6–8 weeks prepartum is supported by a long list of retrospective studies (see, for example, Makuza and McDaniel, 1996; Kuhn et al., 2006). However, although, these retrospective studies had the advantage of a large number of animals, the cows were not managed to have a short dry period, i.e. were not randomly assigned to differing lengths of dry period (Bachman and Schairer, 2003; Grummer and Rastani, 2004). Additionally, relationships between length of the dry period and factors such as metabolic status, disease incidence, and fertility have rarely been evaluated.

The potential that cow health and fertility could be improved by shortening the dry period justifies re-evaluation of the length of the dry period for modern dairy cows. The objective of the present study was to systematically review current knowledge on dry period length in relation to milk production, EB, fertility, and health of cows. The approach was to systematically review randomized controlled studies that included a control group of cows

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that had a conventional dry period of about 8 weeks and to perform a meta-analysis for those variables where at least five independent studies were available. The article is written in compliance with the PRISMA statement (Liberati et al., 2009).

Materials and methods

Search strategy

A systematic literature search was performed to identify randomized controlled studies that examined the effects of length of the dry period on milk production, health, plasma metabolites, and fertility in dairy cows, using three databases: PubMed, Google Scholar, and Scopus. Titles, abstracts and keywords were searched from study start until 6 December 2012. The search terms specified were 'dry period length' OR 'continuous milking' AND 'dairy cow' OR 'dairy cattle'. Publications were screened by the first two authors and bibliographies were reviewed to identify further publications. Consensus over ambiguous information was achieved following discussion between the first two authors, and was not sought from the original researchers.

Inclusion and exclusion criteria

Studies were included when dairy cows were assigned randomly to dry period lengths and variables of milk production or composition, body condition, metabolism, health or fertility were measured. No restrictions on publication data, type or quality were imposed. Studies were excluded if data were analysed retrospectively, if cows were not assigned randomly to dry period lengths, if half-udder models were used or if studies were not in the English language.

Data collection and extraction

Data from publications were extracted on dry period length, parity, stage of lactation during the study period, and on results for milk production and composition, body condition, metabolism, health, fertility, and calf performance. Data were extracted by the first author and tabulated in Excel 2007 (Microsoft).

Data presentation and analysis

Milk production and composition data are presented by plotting the average for the control group with a conventional dry period (49–63 days) against the average result of the 'treatment' group; either short (28–35 days) or no dry period, of the studies. If milk production (kg/day), milk fat% and milk protein% were reported, average fat-and-protein corrected milk (FPCM) (4% fat and 3.3% protein; CVB, 2007) was calculated per treatment group. If fewer than five studies per variable were available, then the review of these papers was descriptive. If at least five independent studies per variable were available, then meta-analysis was conducted using Comprehensive Meta-Analysis (CMA) version 2.0 (Biostat). Studies were included in the meta-analysis if (1) units of measurements were uniform or could be transformed into the same unit; (2) variables were continuous either SD per treatment or *P*-value for treatment difference were reported; (3) variables were dichotomous, number of events (e.g. disease incidence) and sample size per treatment group were reported. For continuous variables, means per treatment (conventional = control, short or no dry period), sample size per treatment and *P*-value for treatment differences were input variables. If no true *P*-values were reported but if cut-off values for significance were reported, then $P < 0.05$ was redefined as $P = 0.049$ and $P > 0.05$ was redefined as $P = 0.051$.

Meta-analysis was applied to estimate the size of the treatment effects on milk production, milk fat and protein percentage, days open, and services per conception. Data are presented as overall mean differences between control (conventional dry period) and treatment (short or no dry period) groups and its confidence interval. For dichotomous variables, sample size and number of events per treatment and control group were input variables. Meta-analyses were used to estimate the overall odds ratio for the incidence of mastitis, metritis, retained placenta, displaced abomasum, and ketosis. As the assumption was made that individual studies estimated different treatment effects, data were analysed using random-effects models.

Results

In total, 24 articles met the inclusion criteria. Of these 24, 22 reported milk production, two reported EB, 12 reported at least one plasma metabolite, six reported disease incidence postpartum and seven reported measures of fertility in relation to dry period length. Milk production, milk fat and protein percentage, incidence of mastitis, metritis, retained fetal membranes, and displaced abomasum met the criteria for a meta-analysis of effects of short or no dry period compared with a conventional dry period.

Milk production characteristics

Fig. 1 provides an overview of studies that reported milk production and composition effects of a shortened or no dry period compared with a conventional dry period. Across studies, cows with a short dry period produced 1.4 kg/day less milk ($P < 0.01$) than cows with a conventional dry period (Table 1), with an average milk loss of 4.5% (range: −3.2% to 13.2%). Across studies, cows with no dry period produced 5.9 kg/day less milk ($P < 0.01$) than cows with a conventional dry period, with an average milk loss of 19.1% (range: 9.0 to 28.9%). These results indicate that both shortening the dry period to about 30 days and omitting the dry period decreases milk production in the next lactation. However, a crucial caveat is that most studies on dry period length did not differentiate between cows of different ages. Pezeshki et al. (2007) indicated that the reduction in milk production after short dry period is larger for young cows (parity 2), compared with older cows. Moreover, both Annen et al. (2004) and Santschi et al. (2011a) reported a reduction in milk production after short or no dry period for young cows (parity 2), but not for older cows.

In contrast, omitting the dry period has a positive effect on milk protein content during early lactation (Table 1). Overall, milk protein percentage increased postpartum (from 21 to 305 days in milk [DIM]) on average by 0.06 ± 0.02% ($P < 0.01$) when the dry period was shortened, and by 0.25 ± 0.04% ($P < 0.01$) when the dry period was omitted. Milk fat percentage was not affected by dry period length ($P > 0.05$).

The additional prepartum milk production attributable to a shorter dry period was determined in only four studies (Fig. 2). The first three of these studies monitored milk yield during a limited period post-calving and reported that the additional milk yield pre-calving completely compensated for the reduced milk yield in the first part of the next lactation (10, 7, or 17 weeks, respectively) (Annen et al., 2004; Andersen et al., 2005; Rastani et al., 2005). When milk yield was monitored in the entire next lactation (305 DIM), cows without a dry period produced 10,633 kg of milk, whereas cows with a 56 day dry period produced 11,310 kg of milk (Schlamberger et al., 2010) (no statistical analysis reported).

Thus, although the meta-analysis showed that shortening the dry period reduced milk production in the next lactation, the increase in milk protein content and in milk production pre-calving might reduce the economic costs of the loss in milk production, especially when differentiating between cows of different ages. The physiological mechanisms behind reduced milk yield of continuously milked cows is not completely understood yet, although both reduced mammary-cell renewal prepartum (Capuco et al., 1997) and lower mammary-nutrient uptake postpartum (Madsen et al., 2008) might play a role.

Energy balance

Shortening the dry period resulted in improved EB in early lactation (−4.1 vs. −7.0 Mcal/d ($P < 0.05$) (Rastani et al., 2005)), whereas omitting the dry period resulted in absence of a negative EB during the first 56 days of lactation (0.7 vs. −7.0 Mcal/day ($P < 0.01$) (Rastani et al., 2005)) or during the first 4 weeks of lactation (1.61 vs. −1.92 Mcal/day ($P < 0.01$) (de Feu et al., 2009)) compared with a conventional dry period of 56 days. Several studies have reported improved body condition score (BCS) (Gulay et al., 2003; Watters et al., 2008; de Feu et al., 2009; Schlamberger et al., 2010) or reduced BCS loss (Rastani et al., 2005; Pezeshki et al., 2008) postpartum after a shortened or omitted dry period.